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CONTRIBUTIONS TO THE PLEISTOCENE FLORA OF CANADA

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EARLY in the present year I received from Professor A. P. Coleman of Toronto University, a very fine collection of leaves from the Interglacial deposits of the Don Valley, Toronto. With them there was one small but rather well preserved fragment of a woody branch which it was possible to identify with accuracy. These specimens prove to be important since they serve to confirm in rather striking ways, conclusions already reached through previous studies of the Don material, and they furthermore afford additional evidence bearing upon the preglacial existence of types now unknown in the living state. It is therefore thought desirable to place on record such facts as are revealed by a study of this collection.

The last previous record of the Don plants was made by me in 1904 ('04) when thirteen species were passed in review. Since then both Berry ('06) and Hollick ('06) have added to our knowledge of the Pleistocene of Virginia and Maryland, and the evidence they bring forward goes to show that essentially the same flora characterized the entire region between Virginia and Ontario in Pleistocene time. The following species are included in the present studies:—

***Acer pleistocenicum* Penh.**— This species appears for the fourth time in collections from the Don Valley, and in the present instance it forms a large percentage of the entire material. Most of the specimens are in fragments, but one or two are nearly perfect. One of the best of these is reproduced here on a diminished scale (Fig. 1), as it is more complete than that employed for the original description ('90, 327).

In the last enumeration of Canadian Pleistocene plants ('04, 72), attention was directed to the very close resemblance between *Acer pleistocenicum* Penh., and *A. lesquereuxii* Knowlton ('98) and the opinion was then expressed that the two are undoubtedly the

same. With the possibilities arising from more extended comparison of material representing a wider range of variations, the conviction becomes stronger that the opinion so stated is a tenable one.

Acer torontoniensis n. sp.—The Don collection embraces a number of specimens, some of them fairly perfect, representing a species of maple altogether unknown, either in the fossil or the living state. This leaf appears to present two principal variations which depend in part upon the relative depths of the principal sinuses and the character of the minor lobes or teeth, but chiefly upon the fact that in one form the base of the leaf is only slightly if at all lobed, while in the other case two large lobes extend downward from the insertion of the blade on the petiole and enclose the latter. Two principal veins extend from the base of the midrib to the corresponding principal lobes, and two subordinate veins of varying prominence extend diagonally downward from near the same point, into the two minor and variable lobes which form the base of the leaf blade. From this description, as also from the two specimens shown in Fig. 2 it will be seen that this leaf belongs to the same group with our common hard maples. Comparison with these latter also shows that its nearest representative among existing species is the common rock or sugar maple, *Acer saccharinum* Wang. Comparing the upper fossil of Fig. 2 with one of the more ordinary types of leaf of the sugar maple, it appears that the chief points of difference are to be found in the form of the sinuses and in the character of the large teeth or smaller lobes. If again we compare the lower fossil leaf in Fig. 2 with the corresponding type of leaf of the sugar maple, the resemblance becomes much stronger by reason of the similar basal lobes, which have unfortunately been much broken away in the fossil. The differences noted are such as might well result from changes incident to natural development, whereby the more simple tends in the direction of the more compound, and when to this there are joined the actual resemblances, they suggest a very intimate relation between the existing sugar maple and the fossil, of such a character as to indicate that the latter may be the ancestral form of the former.

A comparison of leaves of the sugar maple with those of the

Norway maple will show that although they differ materially with respect to venation, they resemble one another in a very remarkable manner as to the form of the sinuses and the detailed configuration of the lobes. These resemblances between two such well defined species, are precisely of the same order as those which are recognized in a comparison of the fossil with the sugar maple. It therefore becomes obvious that in the absence of flowers and fruit, it is not possible to effect a satisfactory specific differentiation

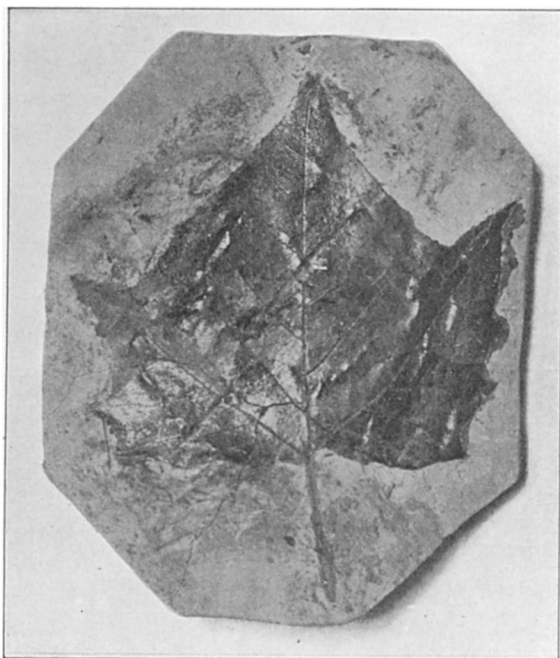


FIG. 1. *Acer pleistocenicum* Penh. $\times 0.55$.

on the basis of leaf form only, but upon this basis the form now under discussion must be regarded as altogether different from any previously recognized fossil or recent species. The diagnosis of this leaf may be stated as follows:—

Leaves strongly and palmately veined; two principal veins arising at the base of the midrib and traversing the principal lobes; two inferior veins of varying prominence arising from near the same position but extending diagonally downward into the inferior lobes. Leaves three to five lobed; the two basal lobes variable,

sometimes small and inconspicuous, or prominent and extending downward so as to enclose the petiole as in *Acer saccharinum* Wang.; the sinuses broad and shallow; the terminal lobe with two large, lateral teeth; the lateral lobes with one or two large teeth on the lower side; the teeth acute, rarely somewhat acuminate toward the summit.

Hollick ('06, 234) has recently observed the occurrence of maple fruits in the Pleistocene of Maryland, but it is at present impossible to connect them definitely with any of the recognized leaves or wood so far studied.

Carya alba Nutt.—Although never abundant, the leaves of the hickory have been noted in three former collections from the Don. Their form and venation are so characteristic as to leave little room for doubt as to their true character.

Hollick ('06, 221, 222) now records the occurrence of three species, one from the Talbot and two from the Sunderland Formation of Maryland. Only one of these is specifically recognizable, and to this the name *Hicoria pseudo-glabra*, Hollick, is assigned.

Cercis canadensis L.—The red-bud, an altogether new constituent of the Don flora, is represented in the present collection by a few leaf fragments which are nevertheless sufficient to establish the identity of the species.

Cyperus sp.—Fragments of jointed stems showing a finely striated surface are referable to the genus *Cyperus* without specific differentiation. Such fragments are of common occurrence in material from the Pleistocene, and they possess little or no significance with respect to a knowledge of climatic conditions.

Gleditschia donensis n. sp.—One or two leaflets are clearly comparable with those of the genus *Gleditschia* to which they are referred under the name of *G. donensis*.

The genus is at present represented in North America by two species ('02, 76) of which the common three-thorned acacia, *G. triacanthos*, seems to be more nearly related to the fossil, and presents the closer resemblance with respect to geographical location.

Maclura aurantiaca Nutt.—One imperfect leaf is referable to the osage orange. Although not now growing in the same region,

this species has been recorded on previous occasions as occurring in the Don deposits of which it is a recognized feature.

Picea nigra Link.— This species is a constant constituent of the Don flora and has been recognized in nearly all previous collec-

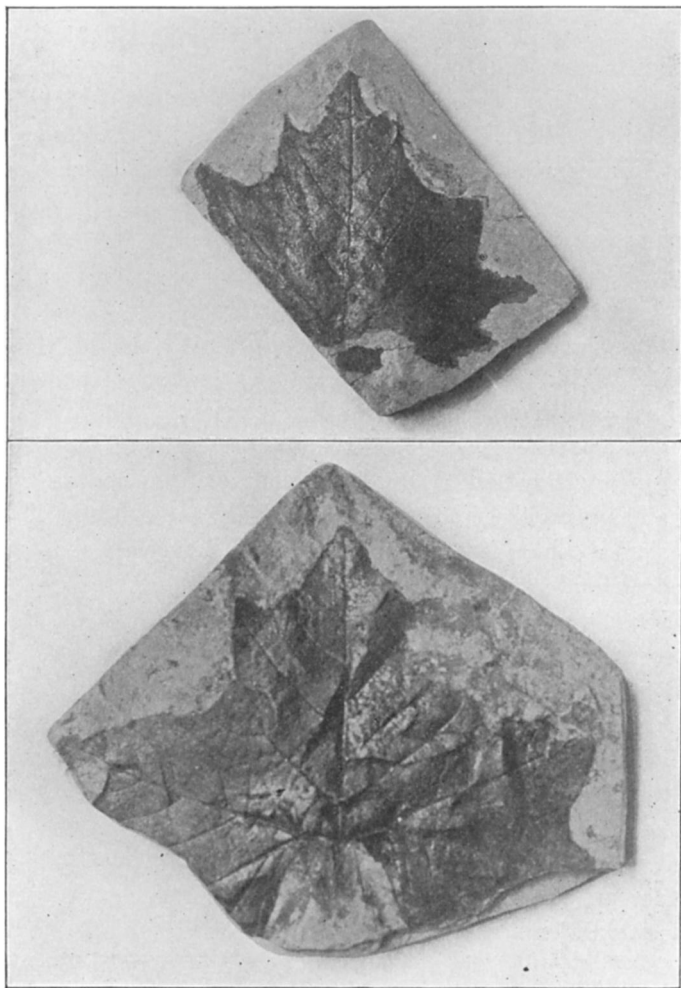


FIG. 2. *Acer torontoniensis* n. sp. $\times 0.55$.

tions. As now, it is always represented by fragments of wood, usually small branches in a more or less altered condition.

Ostrya virginica Willd.— Although not recorded as embraced in

any previous collection from the Don, the leaves contained in the present one are sufficiently characteristic to make the determination reliable.

Platanus occidentalis L.—One small and imperfect leaf shows the characteristic venation of the sycamore. Although not often represented, this tree has nevertheless been found in a previous collection representing two localities, and it is a recognized constituent of the Don flora.

Hollick ('06, 231, 232) has shown the occurrence of *P. aceroides* Goepp., together with another large leaved but unnamed species, in the Sunderland Formation of Maryland.

Populus grandidentata Michx.—This well known but sparingly represented species is a well recognized element of the Don flora, and it once more appears in the present collection.

Prunus sp.—The genus is represented in the present instance by a single drupe of an oblong form. A similar but somewhat shorter fruit has been found on one previous occasion.

Quercus alba L.—The white oak is represented in the present collection by fragmented but well characterized leaves. This species has been observed previously in only one collection. The specimens obtained from Gaol Hill were so imperfect as to make the determination open to some question, but the present material is sufficiently perfect to remove all doubt.

Other oak leaves are also embraced in the 1906 collection, but the fragments are too incomplete to justify reference to a particular species. It is quite probable that they may represent the white oak, but this cannot be stated with any degree of certainty since the Don flora embraces no less than seven recognized species, any one of which they may be.

Under the name of *Quercus pseudo-alba*, Hollick ('06, 227) describes an oak from the Sunderland Formation of Maryland. The leaves which he figures bear a very close resemblance to those from the Don, and it is not unlikely that they may be the same, but a close comparison of more perfect specimens should be made before final decision is reached.

Robinia pseudacacia L.—A few leaflets of the common locust are found in the present collection. This species appears to be rather sparingly represented in the Don flora, since this is only the second time it has been found.

According to Hollick ('06, 234) this species occurs in the Talbot Formation of Maryland, and the leaflets figured by him are identical with those from the Don.

***Tilia americana* L.**—The exceedingly well characterized leaves of the common linden or basswood, occur in the present collection in rather large numbers, some of them being fairly perfect. The species is sparingly represented in the Don Pleistocene, since it has been recognized in only one other collection.

A recent note by E. W. Berry, ('07, 80) directs attention to the occurrence of either *T. americana* or *T. heterophylla* in the Pleistocene clays at Fish House, New Jersey. The imperfect condition of the fossils makes it impossible to determine their correlation with one of the existing species, and in this emergency the specific name *T. dubium* originally assigned by Newberry to the leaves, is now retained but transferred from the genus *Tilliaephyllum*, and the citation therefore becomes *Tilia dubia* (Newb.) Berry.

***Ulmus americana* L.**—The common American or white elm has been identified on former occasions as a prominent constituent of the Don flora, and it is once more represented in the present collection from the same locality.

Lesquereux ('83, pl. LIV, f. 10) has figured under the name of *U. pseudo-americana*, a specimen from the John Day Basin of Oregon (Upper Miocene) which very closely resembles the existing species and may well be regarded as its progenitor.

In a report upon Tertiary plants from the region of the International Boundary in British Columbia, collected by Prof. R. A. Daly in connection with the International Boundary Commission, and now in course of publication, certain elms are described on the basis of their wood structure, and it is seen that they differ but little from some existing species. Among them there is one which differs from the wood of the white elm to about the same extent that the leaf of *U. speciosa* Newb. differs from its more modern representative, *U. americana*. In a collection of woods from the Pleistocene of Elmira, N. Y., now being studied, either this or a closely related species is found, and the evidence therefore tends to show that *Ulmus americana* may be definitely traced back into Miocene time.

Ulmus pseudo-racemosa Hollick, has been found by Hollick in the Sunderland Formation of Maryland ('06, 228), and this

gives one more proof of the wide extension of the same flora, since the Elmira woods contain an elm which will be designated as *U. proto-racemosa*.

BIOLOGICAL CONSIDERATIONS

The present determinations lend emphasis to previous conclusions respecting the character of the Don flora, its relation to existing vegetation in the same region, and its indications of the existence of a climate warmer than at present and comparable with that of the middle and southern United States.

With four exceptions, *Ostrya*, *Gleditschia*, *Cercis* and *Acer torontoniensis*, the flora indicated by the present studies is identical with that previously determined to be characteristic of the Don Period or Warm Climate Period of the Pleistocene. But an examination of these four new elements, shows that they also, are quite consistent factors in the warm climate flora.

Gleditschia triacanthos L. which is undoubtedly the nearest living representative of the fossil, finds its northern limit of distribution according to Macoun ('83), in Ontario, and it occurs on the sand dunes of Pelee Point to which the seeds appear to have been carried across the Lake from Ohio. But according to Sargent ('02, III, 75) this species appears on the western slope of the Alleghany Mountains whence it extends westward as far as longitude 96°, and southward to Alabama, Mississippi and the Brazos River in Texas, from which it would appear that it is distinctly characteristic of a climate warmer than that now known in the region of Toronto, and comparable with that of the Don Period in Pleistocene time.

Cercis canadensis is practically unknown in Canada, although Britton ('97, II, 257) records it as occurring in southern Ontario. Sargent on the other hand ('02, III) gives its northern limit as New Jersey, whence it extends southward to Tampa Bay and westward to the Brazos River in Texas. The evidence which it affords of a warm climate is even more conclusive than in the previous case.

Ostrya virginica ranges from Cape Breton westward through the Valley of the St. Lawrence to Lake of the Woods and Rat Portage, northern Minnesota and the Black Hills of Dakota, and southward to northern Florida and eastern Texas. Although the tree is very common throughout all this region, Sargent ('02,

IX, 35) states that it is most abundant and of largest size in southern Arkansas and adjacent parts of Texas. It is therefore evident that in spite of its wide distribution and high northern range, it is essentially a southern type, and the evidence it affords is therefore in direct accord with that offered by those other representatives of the Don flora now recognized for the first time.

With respect to *Acer pleistocenicum*, very little of a definite character can be said since we know nothing of it except through its occurrence in the Don clays; but its very definite association with a warm climate flora leads to the conclusion that it also must bear the same relations to meteorological conditions, and that it must of necessity be a southern type.

Acer torontoniensis is similarly unknown beyond the Don clays, but the same evidence which applies to *A. pleistocenicum* must lead to similar conclusions with respect to its climatic relations. If this species is to be regarded as the actual progenitor of the sugar maple, it is perhaps somewhat difficult to explain satisfactorily how a southern type, or at least a type with a far southern extension, can have become so altered as to constitute an exclusively northern type, since the converse would be susceptible of a more ready explanation. If on the contrary, this be regarded as a distinct species with adaptation to a more southern climate, it becomes quite easy to understand how it was obliterated from the Toronto region by the southward movement of the ice sheet, in precisely the same manner that other species were driven out of the same area and ultimately confined to more southern localities.

The present studies serve to give renewed emphasis to the idea which has now passed beyond the limits of a working hypothesis, that successive northerly and southerly movements of the continental ice sheet, involving corresponding movements in vegetation, were productive not merely of plant migrations from north to south and *vice versa*, but that they established conditions which permanently eliminated those species which, we may suppose, occupied a somewhat unstable position in the flora and were therefore susceptible to a relatively slight change of surroundings. This conception is in exact accord with the present status of the genus *Sequoia* which, from a very wide distribution extending over the entire northern half of the continent as far as Alaska and Greenland, has become restricted to a very limited area on the

western slopes of the Sierra Nevada Mountains where, according to Gray ('89, II, 147) the two species now occupy an unstable position of such character that "a little further drying of the climate would precipitate their doom."

The evidence afforded by the Pleistocene clays of Toronto is therefore in accord, in this respect, with that furnished by certain Pleistocene deposits at Elmira, New York, and by the conclusions elsewhere stated with respect to the recession of *Sequoia*, *Taxodium*, and probably also *Pseudotsuga*, from the present Great Plains region of Saskatchewan and Alberta ('04, 64-65).

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